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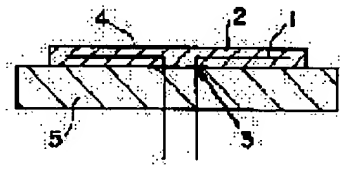
(54) ELECTROSTATIC CHUCK

(57)Abstract:

PURPOSE: To obtain an electrostatic chuck having a quick response characteristic, enabling an increase of the number of sheets handled for a unit time and having an excellent performance by a method wherein the surface roughness Ra on the attracting surface side of an insulative dielectric layer covering an electrode is made a specified value or below and also the degree of flatness is made a specified value or below.



CONSTITUTION: This electrostatic chuck has a structure formed by covering the opposite sides of an electrode 1 with an insulative dielectric layer 2 constituted of a sintered and/or thermally sprayed ceramic. In this electrostatic chuck, the surface roughness Ra on the attracting surface side of the insulative dielectric layer 2 is made 0.25μm or below and also the degree of flatness 20μm or below. The constituent of the insulative dielectric layer 2 is an aluminum oxide, an aluminum nitride, a silicon nitride, a silicon oxide, a zirconium oxide, a titanium oxide, SIALON, a boron nitride, a silicon carbide or a mixture of them. The insulative dielectric layer 2 is polished by using abrasive grains of diamond, the silicon carbide, a cerium oxide, the aluminum oxide or the like.

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CLAIMS

[Claim(s)]
[Claim 1] The electrostatic chuck characterized for flatness by the bird clapper as 20 micrometers or less in the electrostatic chuck which has the structure which covered the both sides of an electrode with the insulating dielectric layer which consists of a sintered compact and/or thermal-spraying ceramics while setting surface roughness Ra by the side of the adsorption side of this insulating dielectric layer to 0.25 micrometers or less.
[Claim 2] The electrostatic chuck indicated to the claim 1 which is what an electrode becomes from ceramics or such mixture, such as metals, such as aluminum, iron, copper, silver, gold, titanium, a tungsten, molybdenum, and platinum, graphite, carbon, silicon carbide, a titanium nitride, and a titanium carbide.
[Claim 3] The electrostatic chuck indicated to the claim 1 which is what the component of an insulating dielectric layer becomes from an aluminum oxide, alumimium nitride, a nitriding silicon, an oxidization silicon, a zirconium oxide, titanium oxide, sialon, a boron nitride, silicon carbide, or such mixture.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] Since adsorption maintenance of this invention can be carried out and it can carry out the desorption of an electrostatic chuck especially conductivity, and the half-conductive or insulating object to electrostatic easily strongly, it relates to the electrostatic chuck made useful at a semiconductor, the manufacture process of liquid crystal, etc.
[0002]
[Description of the Prior Art] The manufacture which the automation and dry-ization are progressing in recent years about processes, such as dry etching of a semiconductor, or a liquid crystal manufacture process and a semiconductor device, an ion implantation, and vacuum evaporationo, therefore is used under vacuum conditions has also been increasing. Moreover, as for a silicon wafer, glass, etc. as a substrate, the diameter-ization of macrostomia progresses, and importance has been increasingly attached also to the position precision at the time of patterning with high integration of a circuit, and detailed-izing. Therefore, although the vacuum chuck is used for conveyance and adsorption fixation of a substrate Though it cannot be used since this thing does not have a pressure differential under vacuum conditions, but this is able to adsorb a substrate under gassiness again, since an adsorption portion is attracted locally A partial distortion arises in a substrate, and there is disadvantage that highly precise alignment is not made, therefore let this vacuum chuck be an unsuitable thing at the latest semiconductor and the manufacture process of liquid crystal.
[0003] Although a substrate is conveyed, or the electrostatic chuck which carries out adsorption fixation of this attracts attention and it is beginning to be used as what has improved this fault using an electrostatic force, since the flatness of the wafer which is a substrate, or a glass plate is becoming important with detailed-izing, in the manufacture process of the latest semiconductor or liquid crystal, using an electrostatic chuck for the reform has also been examined. Although this electrostatic chuck generally covers the both sides of an electrode with ceramics, such as a sintered compact, and is built and a means to impress voltage to demonstrating electrostatic force at the electrode of this interior is required for an electrostatic chuck, this prepared the electrode electric supply section which leads to some ceramics to cover from the outside to an electrode, and has realized it by arranging lead wire etc. from an external power supply to this electrode electric supply section.
[0004] and when the material which can be soldered is used like copper, platinum, and the tungsten

that gave nickel-plating metallurgy plating as an electrode, this electrode electric supply section Lead wire is soldered to an electrode with the solder which has the melting point more than an electrostatic chuck service temperature in ceramics through the pore punctured to the electrode. When this electrode is graphite, a tungsten, and the thing that cannot be soldered like a titanium nitride, the structure which carries out silver-solder attachment of the pin with the screw section through a pore at an electrode with the alloy which suited the coefficient of thermal expansion of ceramics is taken.

[0005]

[Problem(s) to be Solved by the Invention] However, when using this electrostatic chuck for the dry process of a semiconductor etc., after impressing voltage After cutting time (electrostatic adsorption-power saturation time) and voltage until an electrostatic adsorption power occurs and it becomes the maximum force Although time (residual-adsorption force decay time) until an electrostatic adsorption power disappears is required, these two time is named generically and called response characteristic, and this response characteristic has a short short desirable thing since processing number of sheets can be made [many] the more the more it kicks This response characteristic is very long actually, the processing number of sheets per unit time also decreases, and there is a trouble that efficiency is very bad.

[0006]

[Means for Solving the Problem] In the electrostatic chuck which has the structure covered with the insulating dielectric layer which this becomes from a sintered compact and/or thermal-spraying ceramics about the both sides of an electrode about the electrostatic chuck by which this invention solved such disadvantage and the trouble, while setting surface roughness Ra by the side of the adsorption side of this insulating dielectric layer to 0.25 micrometers or less, flatness is characterized by the bird clapper as 20 micrometers or less.

[0007] Namely, the result examined variously that this invention persons should develop an electrostatic chuck without disadvantage which was described above, If the surface roughness by the side of the adsorption side of the insulating dielectric layer in the electrostatic chuck which covered the both sides of an electrode with the insulating dielectric layer shall be over 0.25 micrometers and flatness shall exceed 20 micrometers It finds out this electrostatic adsorption-power saturation time and the residual-adsorption force decay time, and that a response characteristic will increase remarkably if it puts in another way. Therefore, since this response characteristic becomes quick by leaps and bounds and processing number of sheets increases when the flatness is set to 20 micrometers or less, while setting surface roughness Ra by the side of the adsorption side of this insulating dielectric layer to 0.25 micrometers or less It checked that a highly efficient electrostatic chuck could be obtained, and this invention was completed. This is explained further in full detail below.

[0008]

[Function] In the electrostatic chuck which has the structure which covered the both sides of an electrode with the insulating dielectric layer which consists of a sintered compact and/or thermal-spraying ceramics as this invention described this above about the electrostatic chuck 0.25 micrometers or less, while setting preferably surface roughness Ra by the side of the adsorption side of this insulating dielectric layer to 0.10 micrometers or less 20 micrometers or less, preferably, since

the response characteristic which is more preferably characterized by the bird clapper as 3 micrometers or less, and was described above according to this becomes quick by leaps and bounds, flatness 10 micrometers or less The processing number of sheets per unit time can be made [many], and the profitableness that a powerful electrostatic chuck can be obtained is given.

[0009] What is necessary is just to perform this formation by screen printing, the spraying process, photo lithography, or plating that this electrode shall just be made from ceramics or such mixture, such as metals, such as aluminum, iron, copper, silver, gold, titanium, a tungsten, molybdenum, and platinum, graphite, carbon, silicon carbide, a titanium nitride, and a titanium carbide, although the electrostatic chuck of this invention shall have the structure which covered the both sides of an electrode with the insulating dielectric layer. Moreover, the composition of this electrode may be the thing of the acyclic type which constitutes another side in an electrostatic chuck, then a thing of a bipolar formula to which this makes two electrodes counter the interior although it is good for the substrate by which one side of an electrode is adsorbed.

[0010] Moreover, although the insulating dielectric layer which constitutes this electrostatic chuck serves as a chuck function part, this shall consist of a sintered compact and/or thermal-spraying ceramics. Therefore, specifically, although this may be the mixture produced by the sintered compact or thermal spraying by plasma, CVD, etc., although this principal component consists of an aluminum oxide (alumina), alumimium nitride, a nitriding silicon, a zirconium oxide, titanium oxide, sialon, a boron nitride, silicon carbide, or such mixture, it should just be ceramics.

[0011] In addition, if the volume resistivity values of an insulating dielectric layer in case the temperature of the wafer held when the volume resistivity value of this insulating dielectric layer has a proper value with the temperature to be used, for example, this is used for a semiconductor device is 20 degrees C or less areohm [1x108 to 1x1013], and cm grade, electrostatic force will demonstrate enough and will not start a device damage, either. Moreover, if the volume resistivity value of an insulating dielectric layer in case the temperature of a wafer is 20 degrees C or more is a grade more thanohm [1x1013] and cm, its leakage current which flows to a wafer will also be small, and it will not destroy the circuit drawn on the wafer. Therefore, about this volume resistivity value, the optimal value for the temperature which uses it, then a very small leakage current flow between an insulator and a wafer, electrostatic force generates this strongly by the Johnsen Rahbeck effect, it will be in a good adsorption maintenance state, and a chuck function part with a good response characteristic will be obtained.

[0012] in addition -- since the electrostatic force of this electrostatic chuck is generally expressed with F=A-epsilon (V/t) and 2 (here F : electrostatic force, epsilon: a dielectric constant, V: voltage, t: thickness, A: constant) -- this insulation -- as long as it is the grade which does not influence at a semiconductor device, you may mix the ceramic powder of a high dielectric, for example, a barium titanate, a lead titanate, a titanic-acid zirconium, PLZT, etc. in the inside of the body

[0013] Since a means to impress voltage to an internal electrode for demonstrating electrostatic force is required for this electrostatic chuck, the electrode electric supply section which leads to some ceramics to cover from the outside to an electrode is prepared, and to arrange lead wire etc. from an external power supply to this electrode electric supply section is needed. however, when the material which can be soldered is used like copper, platinum, and the tungsten that gave nickel-plating metallurgy plating as an electrode in this electrode electric supply section That what is necessary is

just to solder lead wire to an electrode with the solder which has the melting point more than an electrostatic chuck service temperature in ceramics through the pore punctured to the electrode What is necessary is just to make at an electrode the pin which has the screw section with the alloy which suited the coefficient of thermal expansion of ceramics into the structure which carries out silver-solder attachment through a pore, when this electrode is graphite, a tungsten, and the thing that cannot be soldered like a titanium nitride.

[0014] The electrostatic chuck of this invention should just use this practical, making a substrate 5 paste, although it has the structure which covered the both sides of an electrode 1 with the insulating dielectric layer 2 which consists of a sintered compact and/or thermal-spraying ceramics, the electrode electric supply section 3 is formed in this and this front face 4 turns into an adsorption side, as shown in drawing 1 as the drawing of longitudinal section. In addition, what is necessary is just to perform polishing of this insulating dielectric layer using polishing abrasive grains, such as a diamond, silicon carbide (green carbon), a cerium oxide, and an aluminum oxide, although surface roughness Ra by the side of the adsorption side 4 with this insulating dielectric layer is set to 0.25 micrometers or less by this invention and, as for this thing, flatness is set to 20 micrometers or less.

[0015] Since the contact state of a chuck front face and the adsorbate is good as shown in drawing 2 as drawing of longitudinal section of the mechanism of the electrostatic chuck of this invention when this surface roughness Ra and flatness are very small, although movement of a charge is performed smoothly and a response characteristic becomes very quick Conventionally, by the well-known electrostatic chuck, since surface roughness Ra and flatness are large as shown in drawing 3 which showed drawing of longitudinal section of the mechanism, movement of a charge is considered that are few, therefore a response characteristic becomes late.

[0016]

[Example] Although the example of this invention and the example of comparison are given next, surface roughness Ra and flatness of an insulating dielectric layer in an example show the measured value by the following method.

(Surface roughness Ra) It is based on JIS-B0601. a measuring instrument -- DR- 100X31 (sensing-pin formula) [the Kosaka Lab tradename] was used, six sample front faces were measured, and the average (micrometer) was calculated

(Flatness) Using BH506 [the tradename by Mitutoyo Corp.], the height of Z shaft orientations was measured 3 (using XY shaft as a sample front face) times, and 50 places of the front face of a sample were obtained. The value (micrometer) of 150 places is considered as an average. ********.

Mixture which consists of examples 1-3, the example 1 of comparison - 96 % of the weight of 2 aluminum oxide dust, 3 % of the weight of silica powder, and 1 % of the weight of magnesias After adding the butyral-resin 8 weight section, the ethanol 60 weight section, and the dioctyl-phthalate 12 weight section in the 100 weight sections, in them, it kneaded in the ball mill for 50 hours, and the slurry was produced in them.

[0017] Subsequently, this slurry is processed by the vacuum deaerator, a part of the solvent is dispersed, it considers as the thing of 30,000 centipoise viscosity, a doctor blade is used from this slurry, and it is thickness. A 0.7mm green sheet is made and a diameter from this green sheet Two disks of 180mmphi are cut down, a tungsten paste is used for this one green-sheet disk, and it is a bipolar type electrode by screen-stencil. It printed in the shape of a concentric circle at intervals of

2.5mm. Moreover, the phi2mm hole was opened in the green-sheet core of one sheet which remains, and it considered as the electrode electric supply section.

[0018] Moreover, the green sheet of one more sheet which prepared the electrode electric supply section on the printing side of this printed green sheet is piled up. It unifies with the press heated at 100 degrees C, putting the pressure of 80 kg/cm2. after that in the controlled atmosphere of 25% of hydrogen, and 75% of nitrogen Since the sintered compact was obtained when sintered at the temperature of 1,630 degrees C, they are both sides of this sintered compact Bonded-abrasive #3,000 of a diamond It polishes. The slitting distance is changed. surface roughness by 1mm in thickness 0.13 micrometers, Flatness by 0.22 micrometers and 0.10 micrometers 6.8 micrometers, 2.7 micrometers, The thing (examples 1-3) which is 9.2 micrometers, and surface roughness Ra 0.35 micrometers, That (examples 1-2 of comparison) whose flatness is 120.5 micrometers and 150.6 micrometer is manufactured by 0.19 micrometers. To the wolfram electrode currently peeped into through this electrode electric supply section, nickel plating, And it gold-plates and they are 2 and the melting point about lead wire to this. When it soldered with 300-degree C solder, the electrostatic chuck was manufactured and these response characteristics were measured about this, the result as shown in Table 1 was obtained.

[0019]

[Table 1]

項目 / 例No.	Ra (μm)	平面度 (μm)	静電吸着力飽和時間 (sec)	残留吸着力消滅時間 (sec)
実施例 1	0.13	6.8	1.0	1.1
実施例 2	0.22	2.7	1.3	1.5
実施例 3	0.10	9.2	0.9	1.0
比較例 1	0.35	3.5	120.5	480.0
比較例 2	0.19	38.0	150.0	510.5

[0020]

[Effect of the Invention] In the electrostatic chuck which has the structure which covered the both sides of an electrode with the insulating dielectric layer which consists of a sintered compact and/or thermal-spraying ceramics as this invention described this above about the electrostatic chuck Set surface roughness Ra by the side of the adsorption side of this insulating dielectric layer to 0.25 micrometers or less, and as 20 micrometers or less, although characterized by the bird clapper, this flatness Since according to this a response characteristic can make it quick by leaps and bounds as described above, the processing number of sheets per unit time can improve by leaps and bounds and a highly efficient electrostatic chuck can be obtained, the profitableness that it is supposed that this is useful in the manufacture process of a semiconductor or liquid crystal is given.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] A series of drawings of longitudinal section of the electrostatic chuck of this invention are shown.
[Drawing 2] Drawing of longitudinal section of the mechanism of the electrostatic chuck of this invention is shown.
[Drawing 3] Drawing of longitudinal section of the mechanism of the electrostatic chuck of a conventional method is shown.
[Description of Notations]
1 -- Electrode
2 -- Insulating dielectric layer
3 -- Electrode electric supply section
4 -- Adsorption side
5 -- Substrate
6 -- Wafer
7 -- Flow of a charge

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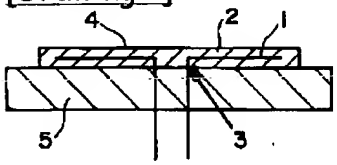
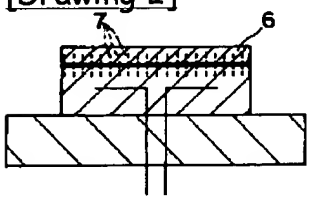
DRAWINGS

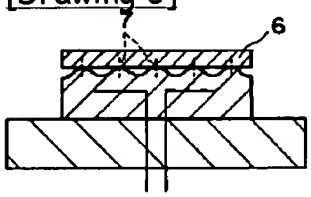
[Drawing 1]



[Drawing 2]



[Drawing 3]



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